Claims

1. A host cell transformed with a nucleic acid construct comprising a nucleotide sequence encoding a xylose isomerase, whereby the nucleic acid construct upon transformation of the host cell, confers to the host cell the ability of isomerising xylose to xylulose.

2. A transformed host cell according to claim 1, wherein the nucleotide sequence is selected from the group consisting of:

(e) nucleotide sequences encoding a polypeptide comprising an amino acid sequence that has at least 40 % sequence identity with the amino acid sequence of SEQ ID NO. 1;

(f) nucleotide sequences comprising a nucleotide sequence that has at least 40% sequence identity with the nucleotide sequence of SEQ ID NO. 2;

(g) nucleotide sequences the complementary strand of which hybridises to a nucleic acid molecule sequence of (a) or (b);

(h) nucleotide sequences the sequence of which differs from the sequence of a nucleic acid molecule of (c) due to the degeneracy of the genetic code.

3. A transformed host cell according to claim 2, wherein the host cell is a yeast, preferably a yeast that belongs to one of the genera: *Saccharomyces*, *Kluyveromyces*, *Candida*, *Pichia*, *Schizosaccharomyces*, *Hansenula*, *Kloeckera*, *Schwanniomyces*, and *Yarrowia*.

4. A transformed host cell according to claim 3, wherein the yeast belongs to one of the species: *S. cerevisiae*, *S. bulderi*, *S. barnetti*, *S. exiguus*, *S. uvarum*, *S. diastaticus*, *K. lactis*, *K. marxianus*, and *K. fragilis*.

5. A transformed host cell according to claim 2, wherein the host cell is a filamentous fungus, preferably a filamentous fungus that belongs to one of the genera: *Aspergillus*, *Trichoderma*, *Humicola*, *Acremonium*, *Fusarium*, and *Penicillium*.

6. A transformed host cell according to any one of the preceding claims, whereby the whereby the nucleotide sequence encoding a xylose isomerase is operably linked to a promoter that causes sufficient expression of the xylose isomerase in the host cell, to confer to the host cell the ability to isomerise xylose into xylulose.

7. A transformed host cell according to claim 6, whereby the promoter is insensitive to catabolite repression in the host cell.

8. A transformed host cell according to any one of the preceding claims, whereby the host cell comprises a genetic modification that result in a characteristic selected from the group consisting of:

(a) increase transport of xylose into the host cell;

(b) increased xylulose kinase activity;

(c) increased flux of the pentose phosphate pathway;

(d) decreased sensitivity to catabolite respression;

(e) increased tolerance to ethanol, osmolarity or organic acids; and,

(f) reduced production of by-products.

9. A transformed host cell according to claim 8, wherein the genetic modification consist of overexpression of endogenous genes, expression of a heterologous genes, or a combination thereof, and whereby the gene is selected from the group consisting of a gene encoding: a hexose or pentose transporter, an xylulose kinase; an enzyme from the pentose phosphate pathway, a glycolytic enzyme, and an ethanologenic enzymes.

10. A transformed host cell according to claim 8, wherein the genetic modification consist of the inactivation of an endogenous genes, whereby the gene is selected from the group consisting of a gene encoding a hexose kinase gene, the *Saccharomyces MIG1* and *MIG2* genes and hybridising homologues thereof.

11. A transformed host cell according to any one of the preceding claims, whereby the host cell expresses one or more enzymes that confer to the host cell the ability to produce lactic acid, acetic acid, succinic acid, amino acids, 1,3-propane-diol, ethylene, glycerol, β-lactam antibiotics and cephalosporins.

12. A transformed host cell according to claim 11, whereby the host cell contains a genetic modification that results in decreased alcohol dehydrogenase activity.

13. An isolated nucleic acid molecule comprising a nucleotide sequence encoding a xylose isomerase, whereby the nucleic acid molecule is selected from the group consisting of:

(a) nucleic acid molecules encoding a polypeptide comprising an amino acid sequence that has at least 53 % sequence identity with the amino acid sequence of SEQ ID NO. 1;

(b) nucleic acid molecules comprising a nucleotide sequence that has at least 57% sequence identity with the nucleotide sequence of SEQ ID NO. 2;

(c) nucleic acid molecules the complementary strand of which hybridises to a nucleic acid molecule sequence of (a) or (b); and,

(d) nucleic acid molecules the sequence of which differs from the sequence of a nucleic acid molecule of (c) due to the degeneracy of the genetic code.

14. An isolated nucleic acid molecule comprising a nucleotide sequence encoding a xylose kinase isomerase, whereby the nucleic acid molecule is selected from the group consisting of:

(e) nucleic acid molecules encoding a polypeptide comprising an amino acid sequence that has at least 47 % sequence identity with the amino acid sequence of SEQ ID NO. 3;

(f) nucleic acid molecules comprising a nucleotide sequence that has at least 37% sequence identity with the nucleotide sequence of SEQ ID NO. 4;

(g) nucleic acid molecules the complementary strand of which hybridises to a nucleic acid molecule sequence of (a) or (b); and,

(h) nucleic acid molecules the sequence of which differs from the sequence of a nucleic acid molecule of (c) due to the degeneracy of the genetic code.

15. A process for producing ethanol, whereby the process comprises the steps of:

(a) fermenting a medium containing a source of xylose with a transformed host cell as defined in any one of claims 1 - 10, whereby the host cell ferments xylose to ethanol, and optionally,

(b) recovery of the ethanol.

16. A process according to claim 15, whereby the medium also contains a source of glucose.

17. A process according to claims 15 or 16, whereby the volumetric ethanol productivity is at least 0.5 g ethanol per litre per hour.

18. A process according to claims any one of claims 15 - 17, whereby the ethanol yield is at least 50 %.

19. A process for producing a fermentation product selected from the group consisting of lactic acid, acetic acid, succinic acid, amino acids, 1,3-propane-diol, ethylene, glycerol, β-lactam antibiotics and cephalosporins, whereby the process comprises the steps of:

(a) fermenting a medium containing a source of xylose with a transformed host cell as defined in claims 11 or 12, whereby the host cell ferments xylose to the fermentation product, and optionally,

(b) recovery of the fermentation product.

20. A process according to claim 19, whereby the medium also contains a source of glucose.

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

Van westenbrugge, A.
NEDERLANDSCH OCTROOIBUREAU
Scheveningseweg 82
(P.O. Box 29720)
NL-2502 LS The Hague
PAYS-BAS

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

	Date of mailing *(day/month/year)* 26.04.2004
Applicant's or agent's file reference P044829PCT BSW/do	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/NL 03/00049	23.01.2003	23.01.2002

Applicant
ROYAL NEDALCO B.V. et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international preliminary examining authority:	Authorized Officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Brandt, M Tel. +49 89 2399-2926

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P044829PCT BSW/do	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/NL 03/00049	International filing date *(day/month/year)* 23.01.2003	Priority date *(day/month/year)* 23.01.2002
International Patent Classification (IPC) or both national classification and IPC C12N15/61		
Applicant ROYAL NEDALCO B.V. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
01.08.2003	26.04.2004
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Dumont, E Telephone No. +49 89 2399-7704

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/NL 03/00049

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

1-22 as originally filed

Claims, Numbers

1-17 received on 13.04.2004 with letter of 13.04.2004

Drawings, Sheets

1/1 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   - ☐ the description, pages:
   - ☐ the claims, Nos.:
   - ☐ the drawings, sheets:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT International application No. PCT/NL 03/00049

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-17
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-17
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-17
	No:	Claims	

2. Citations and explanations

see separate sheet

INTERNATIONAL PRELIMINARY EXAMINATION REPORT - SEPARATE SHEET

International application No. PCT/NL03/00049

Reference is made to the following documents:

D1: DATABASE EMBL [Online] 3 March 2000 (2000-03-03) OP DEN CAMP H.J.M.: 'Piromyces sp. E2 mRNA for xylose isomerase (xylA gene)' Database accession no. AJ249909 XP002201310

D3: WO 96 24667 A (PRIMALCO LTD ;SUOMALAINEN IRMA (FI); AHO SIRPA (US); SAARELAINEN R) 15 August 1996 (1996-08-15)

D5: Harhangi et al., Arch Microbiol. (2003) 180: 134-141 (cited by the Applicant)

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

The subject-matter of claims 1-17, which relates to a eukaryotic host cell transformed with a xylose isomerase having at least 70% sequence identity with the specific xylose isomerase according to SEQ ID NO: 1 isolated from the fungus *Piromyces sp. E2*, is considered novel and inventive with regard to the cited prior art.

In the prior art, expression of prokaryotic xylose isomerases in *S. cerevisiae* did not lead to active xylose isomerase, or did not lead to sufficient activity at physiological temperatures (see e.g. D3, p. 2, § 4; present application, p. 2, l. 26-p. 3, l. 8). D3 reports the isolation of a eukaryotic isomerase from barley, and suggests that the eukaryotic barley enzyme will be more efficiently expressed in yeast than bacterial enzymes, because of the genetic similarities between the eukaryotic plant cell from which the enzyme is derived and the eukaryotic yeast cell in which it is expressed (D3, p. 3, § 1).

The *Piromyces* xylose isomerase disclosed in D1 is more closely related to prokaryotic xylose isomerases than to eukaryotic xylose isomerases (D5, post-published document cited by the applicant). It could therefore not have been derived from the prior art that the xylose isomerase from *Piromyces sp. E2* would be expressed in *S. cerevisiae* and would confer to *S. cerevisiae* the ability to grow on xylose as carbon source.